FORM PTO-1390 (REV 5-93) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER: 951/50636

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

U S APPLICATION NO (if known, see 37 CFR 1.5): 10/009594

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP00/09798	06 October 2000	11 November 1999

TITLE OF INVENTION: **INPUT CIRCUIT FOR INDUCTIVE SPEED SENSOR**

APPLICANT(S) FOR DO/EO/US: **Thomas SEIDENFUSS**

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1.	X	This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2.		This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371
3.		This express request to begin national examination procedures (35 U.S.C. 371(f) at any time rather than delay Examination until the expiration of the applicable time limit set in 35 U.S C. 371(b) and PCT Articles 22 and 39(1).
4.	X	A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5.	X	A copy of the International Application as filed (35 U.S.C. 371(c)(2)).
		a. X is transmitted herewith (required only if not transmitted by the International Bureau).
		b. has been transmitted by the International Bureau
		c. is not required, as the application was filed in the United States Receiving Office (RO/US)
6.	X	A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7.		Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
		a. are transmitted herewith (required only if not transmitted by the International Bureau).
		b. have been transmitted by the International Bureau.
		c. have not been made; however, the time limit for making such amendments has NOT expired.
		d. have not been made and will not be made.
8.		A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9.	X	An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)) **(Unexecuted – 2 pages)**
10.		A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Item 11. to 16. below concern other document(s) or information included:

11.	X	An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12.		An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13.	X	A FIRST preliminary amendment.
		A SECOND or SUBSEQUENT preliminary amendment.
14.	X	A substitute specification and marked-up copy thereof.
15.		A change of power of attorney and/or address letter.
16.		Other items or information:

a. **Drawings (1 Sheet, Showing Fig. 1)**
b. **International Preliminary Examination Report – Form PCT/IPEA/408**
c.

U.S. APPLICATION NO (if known, see 37 CFR 1 5) 10/009594	INTERNATIONAL APPLICATION NO PCT/EP00/09798	ATTORNEY'S DOCKET NUMBER 951/50636	
17. [X] The following fees are submitted:		CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO $ 890.00		$ 890.00	
International preliminary examination fee paid to USPTO (37 CFR 1.482) $ 690.00			
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2) $ 740.00			
Neither international preliminary examination fee (37 CFR 1.482) nor International search fee (37CFR 1.445(a)(2) paid to USPTO $ 1000.00			
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $ 100.00			
ENTER APPROPRIATE BASIC FEE AMOUNT =		$ 890.00	
Surcharge of $130.00 for furnishing the oath or declaration later than [ ] 20 [X] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).		$ 130.00	
Claims	Number Filed	Number Extra	Rate
Total Claims	10 - 20 =	0	X $18.00 $
Independent Claims	3 - 3 =	0	X $84.00 $
Multiple dependent claims(s) (if applicable)			+ $280.00 $
TOTAL OF ABOVE CALCULATIONS =			$1,020.00
Applicant claims Small Entity Status (See 37 CFR §1.27) [ ] yes [ ] no. Reduction by 1/2 for filing by small entity, if applicable.			$
SUBTOTAL =			$
Processing fee of $130.00 for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)).			$
TOTAL NATIONAL FEE =			$1,020.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28,3.31). $40.00 per property +			$
TOTAL FEE ENCLOSED =			$1,020.00
		Amount to be: refunded	$
		Charged	$

a. [X] Check in the amount of **$1,020.00** (filing fee) is enclosed

b. [ ] Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees, which may be required, or credit any overpayment to Deposit Account No. 05-1323 **(Attorney Docket 951/50636)**. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:
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Gary R. Edwards
SIGNATURE
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NAME
31,824
REGISTRATION NUMBER
11 December 2001
DATE

Attorney Docket: 951/50636
PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: THOMAS SEIDENFUSS

Serial No.: NOT YET ASSIGNED PCT No.: PCT/EP00/09798

Filed: DECEMBER 11, 2001

Title: INPUT CIRCUIT FOR INDUCTIVE SPEED SENSOR

PRELIMINARY AMENDMENT

Box PCT **December 11, 2001**
Commissioner for Patents
Washington, D.C. 20231

Sir:

Please enter the following amendments to the specification, claims and abstract, prior to the examination of the application during the U.S. National Phase.

IN THE SPECIFICATION:

Submitted herewith is a substitute specification and marked-up copy thereof.

IN THE CLAIMS:

Please cancel all of the claims presently in the application and substitute new claims 9-18 as follows:

9. (new) An input circuit for receiving and processing signals from an inductive speed sensor, comprising:

a comparator;

a switchable voltage divider which includes first and second resistors; and

first and second circuit inputs each of which is connected to an input of the comparator for evaluating signals from the inductive speed sensor, and with the switchable voltage divider; wherein

the first circuit input is connected via the first resistor to a first input of the comparator, and the second circuit input is connected via the second resistor, which is disconnectable by a switching device, to the first input of the comparator as well;

the switching element is switchable, depending on speed detected by the speed sensor such that, if the speed value is above a predetermined speed, the second resistor is connected, and, if the speed value is below the predetermined speed, the second resistor is disconnected from the second circuit input.

10. (new) The input circuit as claimed in Claim 9, wherein the switching element comprises at least one transistor that is connected to a control device which blocks the at least one transistor at low speed and switches it to a low impedance at high speed.

11. (new) The input circuit as claimed in Claim 9, wherein the at least one transistor is a p-channel MOS field-effect transistor.

12. (new) The input circuit as claimed in Claim 10, wherein said at least one transistor comprises two transistors that are arranged in different switching directions.

13. (new) The input circuit as claimed in Claim 9, wherein a micro-controller of the engine control is used as a control device.

14. (new) The input circuit as claimed in Claim 9, further comprising a voltage divider comprised of two further resistors, one of said further resistors connecting the second circuit input to a preset constant voltage, and the other connecting the second circuit input to ground.

15. (new) The input circuit as claimed in Claim 9, further comprising a resistor that connects the second input of the comparator to the second circuit input, and a resistor that connects the second input of the comparator (K)to its output.

16. (new) The input circuit as claimed in Claim 9, further comprising a pair of Zener-diodes connected with opposite polarities between the first and the second circuit inputs.

17. (new) A circuit for inputting and processing a signal from a speed sensor element, comprising:

a comparator having first and second input terminals;

first and second input circuits connected to receive said signal, said first input circuit being connected to a first input terminal of said comparator, and said second input circuit being connected to a reference voltage and to said second input terminal of said comparator;

a switchable voltage divider circuit interruptibly connecting a voltage divider circuit for reducing an amplitude of the signal on said first input circuit; and

a microprocessor connected to receive and process an output of said comparator and for determining a speed value based thereon;

wherein said microprocessor controls switching said switchable voltage divider based on a magnitude of determined vehicle speed.

18. (new) A method for inputting and processing a signal from a speed sensor, comprising:

applying said signal to a comparator for comparing said signal with a reference value;

processing an output signal from said comparator in a microprocessor to determine whether a preset speed threshold has been exceeded;

when said speed threshold has been exceeded, scaling said input signal downward via a voltage divider circuit prior to said comparing.

IN THE ABSTRACT:

Please add an Abstract of the Disclosure submitted herewith on a separate page.

(Applicant's Remarks are set forth hereinbelow, starting on the following page.)

Serial No. NOT YET ASSIGNED

REMARKS

Entry of the amendments to the specification, claims and abstract, before examination of the application in the U.S. National Phase is respectfully requested.

If there are any questions regarding this amendment or the application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1323 (Docket #951/50636).

Respectfully submitted,

Gary R Edwards

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Registration No. 31,824

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ABSTRACT OF THE DISCLOSURE

A circuit for inputting and processing a signal from a speed sensor element, includes a comparator having first and second input terminals and first and second input circuits connected to receive the signal. The first input circuit is connected to a first input terminal of said comparator, and the second input circuit is connected to a reference voltage and to the second input terminal of said comparator. A switchable voltage divider circuit interruptibly connecting a voltage divider circuit for reducing an amplitude of the signal on said first input circuit; and a microprocessor is connected to receive and process an output of the comparator and to determine a speed value based thereon. The microprocessor controls switching the switchable voltage divider based on the magnitude of determined vehicle speed.

Attorney Docket: 951/50636
PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: THOMAS SEIDENFUSS

Serial No.: TO BE ASSIGNED PCT No.: PCT/EP00/09798

Filed: DECEMBER 11, 2001

Title: INPUT CIRCUIT FOR INDUCTIVE SPEED SENSOR

SUBMISSION OF SUBSTITUTE SPECIFICATION

Box PCT **December 11, 2001**
Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Attached is a Substitute Specification and a marked-up copy of the original specification. I certify that said substitute specification contains no new matter and includes the changes indicated in the marked-up copy of the original specification.

Respectfully submitted,

Gary R. Edwards
Registration No. 31,824
Song Zhu
Registration No. 44,420

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1 / PRTS

Clean Substitute Specification
Attorney Docket No. 951/50636

Input Circuit for Inductive Speed Sensor

BACKGROUND AND SUMMARY OF THE INVENTION

This application claims the priority of PCT International Application No. PCT/EP00/09798, filed 6 October 2000 and German patent document 199 54 115.9, filed November 11, 1999, the disclosure of which is expressly incorporated by reference herein.

The invention relates to an input circuit for a signal from an inductive speed sensor.

Many internal combustion engines use transmitter wheels with inductive sensors to determine, for example, the position of the crankshaft. Not only are inductive sensors of this type rugged and usable at very high temperatures, they are also extremely inexpensive. However, the amplitude of the signal depends on the speed, covering a range from a few millivolts to more than 100 volts. Electronic circuits are normally used in order to be able to detect low amplitudes at low speeds, on the one hand, while reaching, on the other hand, the highest possible level of noise immunity during normal engine operation, i.e. in the presence of high amplitudes. The electronic circuits either divide the existing sensor voltage in one or more stages, or they switch the switching thresholds of evaluating comparators over.

Both of these methods measure the average level of the sensor voltage and effect the switch-over of their evaluation dependent on the latter.

A disadvantage of this process is that it necessarily involves a relatively high level of complex circuitry in order to determine the average amplitude of the signal, to switch-over the thresholds or voltage dividers, to provide a hysteresis for the switch-over and to prevent undesirable additional edges that may occur in the more sensitive area during a switch-back. Therefore, specially designed and costly so-called ASICs are often used.

One object of the present invention is to provide an input circuit of the kind described at the outset that can be used to achieve a high degree of input sensitivity during the start-up phase and a good signal-to-noise ratio during normal engine operation utilizing the simplest means.

This and other objects and advantages are achieved by the input circuit according to the invention, in which a voltage divider for a signal amplitude is no longer switched over on the basis of an average sensor signal value but on the basis of the speed. A precise analysis of the above-mentioned problem

revealed that the low amplitudes occur, for the most part, only during the start-up process (that is, when the engine starter rotates at less than 100 rpm). But once the engine starts, the idling speed is reached within a very short time. Idling speeds, however, are within a range of approximately 500 to 1,000 rpm. At this speed, the amplitude of the transmitter signal reached approximately 10 times the initial amplitude. The amplitude, in turn, changes by a maximum factor of ten across the entire remaining speed range. The invention takes advantage of the dependence of the signal amplitude on speed.

Specifically, a micro-controller can provide the speed to the engine control, where this dimension is already present. The speed thresholds and the switching hysteresis are also easily adjustable with the present invention.

Furthermore, if taking into account that the initial sensitivity level is necessary only during the start-up phase, a simple switch-over threshold will be enough to ensure sufficient noise immunity during normal engine operation.

Other objects, advantages and novel features of the present invention will become apparent from the following detailed

description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The single figure of the drawing depicts an input circuit according to the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring to the Figure, the input circuit according to the invention is comprised of two circuit inputs (or connector pins) 1, 2, to which an inductive transmitter (not shown) can be connected. The two circuit inputs 1 and 2 are loaded via a resistor R1.

The circuit input 2 is connected to a voltage divider, comprised of the resistors R2 and R3, with the resistor R2 connecting the circuit input 2 to the ground, and the resistor R3 being connected to a constant voltage of 5V. The reference level of the transmitter is raised by way of the voltage divider, which is comprised of the resistors R2 and R3; as a result, it is possible to detect negative amplitudes using a comparator K.

The circuit input 1 is connected to a first input (-) of the comparator K via a resistor R4. Two Zener-diodes D1 and D2, connected opposite in relation to each other, are arranged between the resistor R4 and the second circuit input 2; in conjunction with the resistor R4, they protect the comparator K from an input voltage that is too high.

The second input (+) of the comparator K is connected to the circuit input 2 via a resistor R6, and to the output of the comparator K via a resistor R7. The two resistors R6 and R7 define a switching hysteresis.

The output of the comparator K is connected to a micro-controller M (input E) which is used to evaluate the transmitter signal, and which in turn, uses this transmitter information to control the engine.

Another resistor R5 and two p-channel MOS (metal-oxide semiconductor) field-effect transistors T1 and T2 are connected between the resistor R4 and the circuit input 2. Consequently, the first input (-) of the comparator K is connected via the resistor R4 to the circuit input 1 and via the combination of the resistor R5 and the two MOS field-effect transistors T1 and T2 to the circuit input 2. Using the combination of the components

R4, R5, T1 and T2, it is possible to realize a switchable voltage divider and, therefore, a controllable amplitude reduction at the comparator K.

The two MOS field-effect transistors T1 and T2 are necessary because of the negative sensor voltages; and they are both arranged in series and aligned in different switching directions. The inputs of the two MOS field-effect transistors T1 and T2 are connected to an output A of the micro-controller M and controlled by the latter. In the present case, the inductive sensor supplies +/- 1.3 volts at approximately 100 rpm. At 1,000 rpm it generates +/- 12.7 volts. The switching threshold of the comparator is at approximately +/- 1.2 volts. If resistance values of 51.1 kΩ are used for R4 and of 11.5 kΩ for R5, the resulting switching thresholds are higher by a factor of 5 (or approximately +/- 6 volts). This threshold provides a good signal-to-noise ratio.

If a vehicle in which the device is installed is started up and current is supplied to the micro-controller M, latter initially switches the two MOS field-effect transistors T1 and T2 via its output pin A to a high-impedance state. Thus, the sensor signal originating from the inductive sensor or transmitter (not shown) is applied, undamped, at the comparator

K. High amplitudes, however, are limited by way of the two diodes D1 and D2.

The micro-controller M evaluates the digitized signal from the comparator K and emits a signal if the established speed threshold is exceeded. This causes the micro-controller M to switch the MOS field-effect transistors T1 and T2 to a low-impedance level, so that the sensor signal at the comparator K is reduced by the then-active voltage divider consisting of the resistors R4 and R5. The speed determination is now less sensitive with respect to noise in the sensor signal. The resistors - as mentioned above - are selected in such a way that the signal level at the comparator K is sufficient for safe switching even under the poorest conditions. It is beneficial if the change-over speed is below the no-load speed in order to prevent any back and forth switching while the engine is running.

The present invention ensures a high input sensitivity during the start-up phase and a good signal-to-noise ratio during engine operation using the simplest means. Significant cost savings are realized in comparison to a conventional solution that uses a so-called ASIC.

The foregoing disclosure has been set forth merely to illustrate the invention and is not intended to be limiting. Since modifications of the disclosed embodiments incorporating the spirit and substance of the invention may occur to persons skilled in the art, the invention should be construed to include everything within the scope of the appended claims and equivalents thereof.

1 / PRTS

Marked up Substitute Specification
Attorney Docket No. 951/50636

Input Circuit for Inductive Speed Sensor

BACKGROUND AND SUMMARY OF THE INVENTION

This application claims the priority of PCT International Application No. PCT/EP00/09798, filed 6 October 2000 and German patent document 199 54 115.9, filed November 11, 1999, the disclosure of which is expressly incorporated by reference herein.

The invention relates to an input circuit for a signal from an inductive speed sensor. [according to the preamble of claim 1.]

Many internal combustion engines use transmitter wheels with inductive sensors to determine, for example, the position of the crankshaft. Not only are inductive sensors of this type [very] rugged and usable at very high temperatures, they are also extremely inexpensive. However, the amplitude of the signal depends on the speed, covering a range from a few millivolts to more than 100 volts. Electronic circuits are normally used in order to be able to detect low amplitudes at low speeds, on the one hand, while reaching, on the other hand, the highest possible level of noise immunity during normal engine operation, i.e. in the presence of high amplitudes. The electronic circuits either

divide [down] the existing sensor voltage in one or more stages, or they switch the switching thresholds of evaluating comparators over. Both of [the above-named] these methods measure the average level of the sensor voltage and effect the switch-over of their evaluation dependent on the latter.

A disadvantage of [It is disadvantageous that] this process is that it necessarily involves a relatively high level of complex circuitry in order to determine the average amplitude of the signal, to switch-over the thresholds or voltage dividers, to provide a hysteresis for the switch-over and to prevent undesirable additional edges that may occur in the more sensitive area during a switch-back. Therefore, specially designed and costly so-called ASICs are often used.

One object [It is the subject-matter] of the present invention is to provide an input circuit of the kind described at the outset that can be used to achieve a high degree of input sensitivity during the start-up phase and a good signal-to-noise ratio during normal engine operation utilizing the simplest means.

This and other objects and advantages are achieved by the input circuit according to [This objective is achieved with the

characteristics specified in claim 1. A key concept of] the invention, in which [provides that] a voltage divider [of] for a signal amplitude is no longer switched over on the basis of an average sensor signal value but on the basis of the speed. A precise analysis of the above-mentioned problem revealed that the low amplitudes occur, for the most part, only during the start-up process[, i.e.] (that is, when the engine starter rotates at less than 100 rpm). But once the engine starts, the idling speed is reached within a very short time. Idling speeds, however, are within a range of approximately 500 to 1,000 rpm. At this speed, the amplitude of the transmitter signal reached approximately 10 times the initial amplitude. The amplitude, in turn, changes [at] by a maximum factor [10] of ten across the entire remaining speed range. The invention takes advantage of the dependence of the signal amplitude on speed.

Specifically, a micro-controller can provide the speed to the engine control, where this dimension is already present. The speed thresholds and the switching hysteresis are also easily adjustable with the present invention.

Furthermore, if taking into account that the initial sensitivity level is necessary only [necessary] during the start-up phase, a simple switch-over threshold will be enough to ensure

[a] sufficient noise immunity during normal engine operation.

Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[Other characteristics are defined in the sub-claims.]

[In the following, the invention will be described in greater detail utilizing a special embodiment and in reference to the single attached drawing.]

DETAILED DESCRIPTION OF THE DRAWINGS

The single figure of the drawing depicts an input circuit according to the invention. [that]

Referring to the Figure, the input circuit according to the invention is comprised of two circuit inputs (or connector pins) 1, 2, to which an inductive transmitter (not shown [here]) can be connected. The two circuit inputs 1 and 2 are loaded via a resistor R1.

[Moreover, the] The circuit input 2 is connected to a voltage divider, comprised of the resistors R2 and R3, [in such a way that] with the resistor R2 [connects] connecting the circuit input 2 to the ground, and the resistor R3 being connected [connects the circuit input 2] to a constant voltage of 5V. The reference level of the transmitter is raised by way of the voltage divider, which is comprised of the resistors R2 and R3; as a result, it is possible to detect negative amplitudes using a comparator K.

The circuit input 1 is connected to a first input (-) of the comparator K via a resistor R4. Two Zener-diodes D1 and D2, [wired] connected opposite in relation to each other, are arranged between the resistor R4 and the second circuit input 2; in conjunction with the resistor R4, they protect the comparator K from an input voltage that is too high.

The second input (+) of the comparator K is connected to the circuit input 2 via a resistor R6, and [. Also, the second input (+) of the comparator K is also connected] to the output of the comparator K via a resistor R7. The two resistors R6 and R7 define a switching hysteresis.

The output of the comparator K is connected to a micro-controller M (input E) [that] which is used to evaluate the transmitter signal, and which [. The micro-controller M,] in turn, uses this transmitter information to control the engine.

Another resistor R5 and two p-channel MOS [[] (metal-oxide semiconductor) []] field-effect transistors T1 and T2 are [wired] connected between the resistor R4 and the circuit input 2. Consequently, the first input (-) of the comparator K is connected via the resistor R4 to the circuit input 1 and via the combination of the resistor R5 and the two MOS field-effect transistors T1 and T2 to the circuit input 2. Using the combination of the components R4, R5, T1 and T2, it is possible to realize a switchable voltage divider and, therefore, a controllable amplitude reduction at the comparator K.

The two MOS field-effect transistors T1 and T2 are necessary because of the negative sensor voltages; and they are both arranged in series and aligned in different switching directions. The inputs of the two MOS field-effect transistors T1 and T2 are connected to an output A of the micro-controller M and controlled by the latter. In the present case, the inductive sensor supplies +/- 1.3 volts at approximately 100 rpm. At 1,000 rpm it generates +/- 12.7 volts. The switching

threshold of the comparator is at approximately +/- 1.2 volts. If resistance values of 51.1 kΩ are used for R4 and of 11.5 kΩ for R5, the resulting switching thresholds are higher by a factor of 5[, i.e.] (or approximately +/- 6 volts). This threshold provides a good signal-to-noise ratio.

If [the] a vehicle in which the device is installed is started up and current is supplied to the micro-controller M, [the micro-controller M] latter initially switches the two MOS field-effect transistors T1 and T2 via its output pin A to a high-impedance state. Thus, the sensor signal originating from the [(not shown)] inductive sensor or transmitter (not shown) is applied, undamped, at the comparator K. High amplitudes, however, are limited by way of the two diodes D1 and D2.

The micro-controller M evaluates the digitized signal [coming] from the comparator K and emits a signal if the established speed threshold is exceeded. This causes the micro-controller M to switch the MOS field-effect transistors T1 and T2 to a low-impedance level, so that [allowing for] the sensor signal at the comparator K [to be] is reduced by the then-active voltage divider consisting of the resistors R4 and R5. The speed determination is now less sensitive with respect to noise in the sensor signal. The resistors - as mentioned above - are selected

in such a way that the signal level at the comparator K is sufficient for safe switching even under the poorest conditions. It is beneficial if the change-over speed is below the no-load speed in order to prevent any back and forth switching while the engine is running.

The present invention ensures a high input sensitivity during the start-up phase and a good signal-to-noise ratio during engine operation using the simplest means. Significant cost savings are realized in comparison to a conventional solution that uses a so-called ASIC.

The foregoing disclosure has been set forth merely to illustrate the invention and is not intended to be limiting. Since modifications of the disclosed embodiments incorporating the spirit and substance of the invention may occur to persons skilled in the art, the invention should be construed to include everything within the scope of the appended claims and equivalents thereof.

10/009594

Translation of International Application
Attorney Docket No. 951/50636

1/PRTS

WO 01/35108

PCT/EP00/09798

Input Circuit for Inductive Speed Sensor

The invention relates to an input circuit for an inductive speed sensor according to the preamble of claim 1.

Many internal combustion engines use transmitter wheels with inductive sensors to determine, for example, the position of the crankshaft. Not only are inductive sensors of this type very rugged and usable at very high temperatures, they are also extremely inexpensive. However, the amplitude of the signal depends on the speed, covering a range from a few millivolts to more than 100 volts. Electronic circuits are normally used in order to be able to detect low amplitudes at low speeds, on the one hand, while reaching, on the other hand, the highest possible level of noise immunity during normal engine operation, i.e. in the presence of high amplitudes. The electronic circuits either divide down the existing sensor voltage in one or more stages, or they switch the switching thresholds of evaluating comparators over. Both of the above-named methods measure the average level of the sensor voltage and effect the switch-over of their evaluation dependent on the latter.

It is disadvantageous that this process necessarily involves a relatively high level of complex circuitry in order to determine the average amplitude of the signal, to switch-over the thresholds or voltage dividers, to provide a hysteresis for the switch-over and to prevent undesirable additional edges that may occur in the more sensitive area during a switch-back. Therefore, specially designed and costly so-called ASICs are often used.

It is the subject-matter of the present invention to provide an input circuit of the kind described at the outset that can be used to achieve a high degree of input sensitivity during the start-up phase and a good signal-to-noise ratio during normal engine operation utilizing the simplest means.

This objective is achieved with the characteristics specified in claim 1.

A key concept of the invention provides that a voltage divider of a signal amplitude is no longer switched over on the basis of an average sensor signal value but on the basis of the speed. A precise analysis of the above-mentioned problem revealed that the low amplitudes occur, for the most part, only during the start-up process, i.e. when the engine starter rotates at less than 100 rpm. But once the engine starts, the idling speed is reached within a very short time. Idling speeds, however, are within a range of approximately 500 to

1,000 rpm. At this speed, the amplitude of the transmitter signal reached approximately 10 times the initial amplitude. The amplitude, in turn, changes at a maximum factor 10 across the entire remaining speed range. The invention takes advantage of the dependence of the signal amplitude on speed.

Specifically, a micro-controller can provide the speed to the engine control, where this dimension is already present. The speed thresholds and the switching hysteresis are also easily adjustable with the present invention.

Furthermore, if taking into account that the initial sensitivity level is only necessary during the start-up phase, a simple switch-over threshold will be enough to ensure a sufficient noise immunity during normal engine operation.

Other characteristics are defined in the sub-claims.

In the following, the invention will be described in greater detail utilizing a special embodiment and in reference to the single attached drawing.

The single drawing depicts an input circuit according to the invention that is comprised of two circuit inputs (or connector pins) 1, 2, to which an inductive transmitter (not shown here) can be connected. The two circuit inputs 1 and 2 are loaded via a resistor R1.

Moreover, the circuit input 2 is connected to a voltage divider, comprised of the resistors R2 and R3, in such a way that the resistor R2 connects the circuit input 2 to the ground, and the resistor R3 connects the circuit input 2 to a constant voltage of 5V. The reference level of the transmitter is raised by way of the voltage divider, which is comprised of the resistors R2 and R3; as a result, it is possible to detect negative amplitudes using a comparator K.

The circuit input 1 is connected to a first input (-) of the comparator K via a resistor R4. Two Zener-diodes D1 and D2, wired opposite in relation to each other, are arranged between the resistor R4 and the second circuit input 2; in conjunction with the resistor R4, they protect the comparator K from an input voltage that is too high.

The second input (+) of the comparator K is connected to the circuit input 2 via a resistor R6. Also, the second input (+) of the comparator K is also connected to the output of the comparator K via a resistor R7. The two resistors R6 and R7 define a switching hysteresis.

The output of the comparator K is connected to a micro-controller M (input E) that is used to evaluate the transmitter signal. The micro-controller M, in turn, uses this transmitter information to control the engine.

Another resistor R5 and two p-channel MOS [metal-oxide semiconductor] field-effect transistors T1 and T2 are wired between the resistor R4 and the circuit input 2. Consequently, the first input (-) of the comparator K is connected via the resistor R4 to the circuit input 1 and via the combination of the resistor R5 and the two MOS field-effect transistors T1 and T2 to the circuit input 2. Using the combination of the components R4, R5, T1 and T2, it is possible to realize a switchable voltage divider and, therefore, a controllable amplitude reduction at the comparator K. The two MOS field-effect transistors T1 and T2 are necessary because of the negative sensor voltages; and they are both arranged in series and aligned in different switching directions. The inputs of the two MOS field-effect transistors T1 and T2 are connected to an output A of the micro-controller M and controlled by the latter. In the present case, the inductive sensor supplies +/- 1.3 volts at approximately 100 rpm. At 1,000 rpm it generates +/- 12.7 volts. The switching threshold of the comparator is at approximately +/- 1.2 volts. If resistance values of 51.1 kΩ are used for R4 and of 11.5 kΩ for R5, the resulting switching thresholds are higher by a factor of 5, i.e. approximately +/- 6 volts. This threshold provides a good signal-to-noise ratio.

If the vehicle is started up and current is supplied to the micro-controller M, the micro-controller M initially switches the two MOS field-effect transistors T1 and T2 via its output pin A to a high-impedance state. Thus, the sensor signal originating from the (not shown) inductive sensor or transmitter is applied, undamped, at the comparator K. High amplitudes, however, are limited by way of the two diodes D1 and D2.

The micro-controller M evaluates the digitized signal coming from the comparator K and emits a signal if the established speed threshold is exceeded. This causes the micro-controller M to switch the MOS field-effect transistors T1 and T2 to a low-impedance level allowing for the sensor signal at the comparator K to be reduced by the then-active voltage divider consisting of the resistors R4 and R5. The speed determination is now less sensitive with respect to noise in the sensor signal. The resistors - as mentioned above - are selected in such a way that the signal level at the comparator K is sufficient for safe switching even under the poorest conditions. It is beneficial if the change-over speed is below the no-load speed in order to prevent any back and forth switching while the engine is running.

The present invention ensures a high input sensitivity during the start-up phase and a good signal-to-noise ratio during engine operation using the simplest means. Significant cost

savings are realized in comparison to a conventional solution that uses a so-called ASIC.

Input Circuit for Inductive Speed Sensor

Patent Claims:

1. Input circuit for an inductive speed sensor comprised of a first and a second circuit input (1, 2) each of which is connected to an input of a comparator (K) that serves to evaluate the signals from the inductive speed sensor and with a switchable voltage divider that is comprised of two resistors (R4, R5); and the first circuit input (1) is connected via the first resistor (R4) to the first input of the comparator (K), and the second circuit input (2) is connected via a second resistor (R5), which can be disconnected by way of a switching device (T1, T2), to the first input of the comparator (K) as well wherein the switching element (T1, T2) is switchable, depending on the speed, in particular in such a way that, if the speed value is above a predetermined speed, the resistor (R5) is connected to the second circuit input (2), and, if the speed value is below the predetermined speed, it is disconnected from the second circuit input.

2. Input circuit as claimed in claim 1
wherein
the switching element is comprised of at least one transistor (T1, T2) that is connected to a control device (M) which

blocks the transistor (T1, T2) at low speed and switches it to open at high speed.

3. Input circuit as claimed in claim 1 or claim 2
wherein
a p-channel MOS field-effect transistor is envisioned as transistor (T1, T2).

4. Input circuit as claimed in claim 2 or claim 3
wherein
two transistors (T1, T2) are envisioned that are arranged in different switching directions.

5. Input circuit as claimed in one of the preceding claims
wherein
a micro-controller of the engine control is used as control device.

6. Input circuit as claimed in one of the preceding claims
wherein
a voltage divider that is comprised of two resistors (R3, R4) is envisioned, and wherein the resistor (R3) connects the second circuit input (2) to a certain constant voltage, and the other resistor (R4) connects the second circuit input (2) to the ground.

7. Input circuit as claimed in one of the preceding claims wherein

a resistor (R6) is envisioned that connects the second input of the comparator (K) to the second circuit input (2), and wherein a resistor (R7) is envisioned that connects the second input of the comparator (K)to its output.

8. Input circuit as claimed in one of the preceding claims wherein

two Zener-diodes (D1, D2), wired opposite in relation to each other, are envisioned between the first and the second circuit inputs (1, 2).

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

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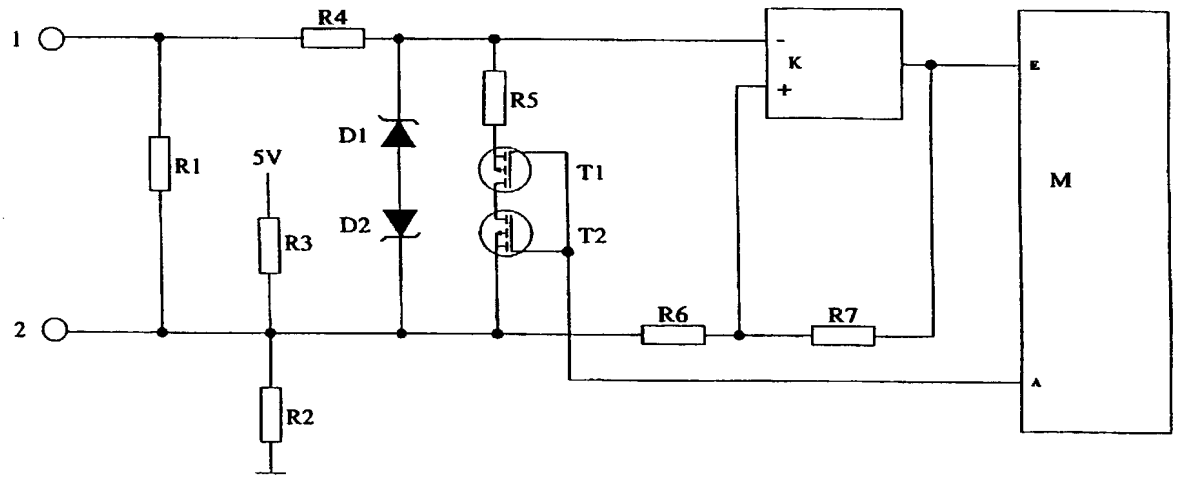
[Fortsetzung auf der nächsten Seite]

(54) Title: INPUT CIRCUIT FOR INDUCTIVE ENGINE SPEED SENSOR

(54) Bezeichnung: EINGANGSSCHALTUNG FÜR INDUKTIVEN DREHZAHLGEBER



(57) Abstract: The invention relates to an input circuit for an inductive engine speed sensor which comprises a first and a second input port that are each linked with an input port of a comparator that is used to evaluate the signals of the inductive engine speed sensor. The input circuit is further provided with a switchable potential divider that comprises two resistors, the first input port being linked with the first input of the comparator via the first resistor and the second input port also being linked with the first input of the comparator via a second resistor that can be decoupled by means of a switchgear. The aim of the invention is enable a high input sensitivity during the starting phase and a good signal-to-noise ratio during the remaining operation of the engine. To this end, the switchgear is switched depending on the engine speed in such a manner that the resistor is linked with the second input port at an engine speed above a predetermined speed and is decoupled from the second input port at an engine speed below the predetermined speed.

[Fortsetzung auf der nächsten Seite]

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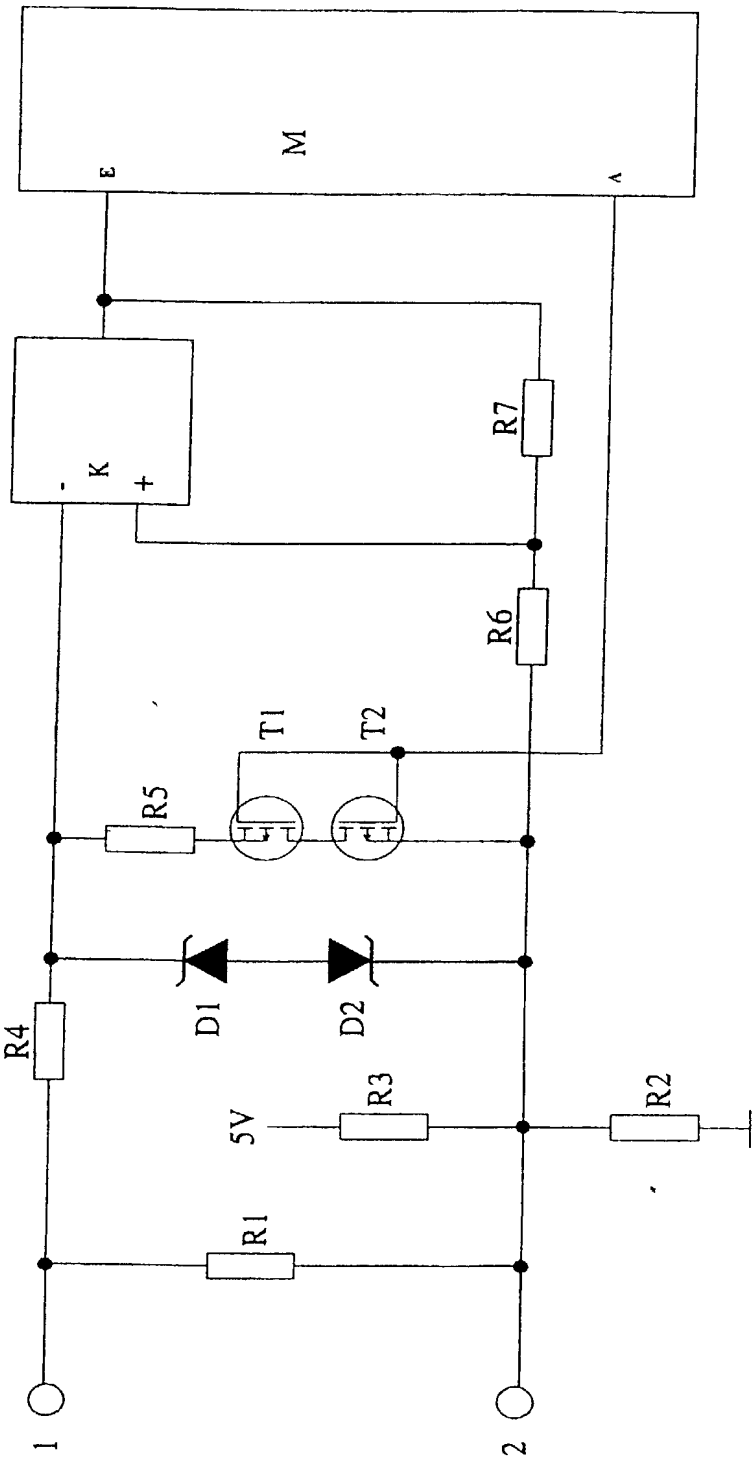
M
E
A
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+
R7
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T1
T2
R5
D1
D2
R4
5V
R3
R2
R1
1
2

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (includes Reference to PCT International Applications)	ATTORNEY'S DOCKET NUMBER **951/50636**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

INPUT CIRCUIT FOR INDUCTIVE SPEED SENSOR

the specification of which (check only one item below):

[ ] is attached hereto.

[ ] was filed as United States application
Serial No.
on
And was amended
on _____ (if applicable).

[X] was filed as PCT international application
Number PCT/EP00/09798
on 06 October 2000 (06.10.00)
and was amended under PCT Article 19
on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations. §1.56(a).

I hereby claim foreign priority benefits under Title 35, United State Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (if PCT indicate PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
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			[ ] Yes [ ] No
			[ ] Yes [ ] No
			[ ] Yes [ ] No
			[ ] Yes [ ] No

Combined Declaration For Patent Application and Power of Attorney (Continued) (includes Reference to PCT international Applications	ATTORNEY'S DOCKET NUMBER **951/50636**

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national of PCT international filing date of this application:

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U.S. APPLICATIONS		STATUS *(Check one)*		
U.S. APPLICATION NUMBER	U.S. FILING DATE	PATENTED	PENDING	ABANDONED

PCT APPLICATIONS DESIGNATING THE U.S.					
PCT APPLICATION NO	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED (IF ANY)			

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration number)

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203	FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
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SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
X Thomas Seidenfuss		
DATE X 12.12.01	Date	DATE